



Materials Engineering Branch

TIP*



No. 133 Concerns with the Use of Titanium Fasteners

Author(s): Fred Gross

Contact: (301) 286-6882

While Ti-6Al-4V is a space flight approved alloy, it possesses a checkered history in tensile fastener applications. For those who have not had experience with this type of fastener, the problems associated with its use may not be evident at first glance.

Usually, the reasons titanium alloys are chosen are the moderately high strength to weight ratio and the good resistance to stress corrosion cracking (SCC). On the other hand, the disadvantages in using these fasteners have caused some serious problems in some flight programs with respect to cost and schedule impact. Examples of this are the fasteners used on the GRO spacecraft structure and GOES-I structure.

The failure of numerous titanium alloy fasteners on GRO caused serious delays and expensive investigations to find the solution to the problem that was quite typical for this material. The GOES problem was not nearly as extensive in scope, but amounted to the same issue; namely, overstressing during installation.

In most cases of failure of titanium alloy fasteners, the design and the material were **not** found to be deficient. The usual reason for these failures is the method and specifications of installation. Firstly, it should be realized that fasteners made from these alloys have moderate ductility and a low work hardening rates. Secondly, there is a very complicated relationship and uncertainty among applied torque, coefficients of friction, joint factors, assembly processes/cycles, misalignment and induced bending/tensile stresses. When a combination of these factors elevates the stress sufficiently, the titanium fastener breaks rather than deforms like a medium strength steel fastener. It is the misjudgment of torque-stress relationship that causes many of the problems.

Titanium fasteners should be selected only where their advantages relative to steel are essential for an application and should never be employed as single point failure tensile fasteners. When using titanium fasteners, engineers must measure all torsional friction loads, torsional preloads, and torsional breaking loads. If one decides to use these alloys, he/she should expect to be especially scrupulous in the design and testing of its application. MSFC-STD-557 should be consulted for usage criteria. Titanium fasteners should be procured from GSFC approved manufacturers. Silver or cadmium plating should not be used, as they can be a source of embrittlement.